Study on Low Temperature Heating Characteristics of Low Temperature Heat Pump Air-Conditioning System for New Energy Vehicle

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Keywords: New Energy Vehicle; Enthalpy Type of Gas Supply, Low Temperature Heat Pump Air Conditioning System, Low Temperature Heating, Characteristics

Abstract: Comparing the low temperature heating performance of air conditioning system with that of ordinary heat pump units, the former can operate in the low temperature heating range above minus 15 degrees Celsius, the compressor exhaust temperature is controlled between 56.3 degrees Celsius and 83 degrees Celsius, the heating capacity of the unit is increased by 17%, and the energy efficiency 0 degrees Celsius, the energy efficiency can be improved to 21%. The problem of high exhaust temperature under low temperature condition of air supply and roasting heat pump is solved, and the serious attenuation of heating performance is restrained. This thesis focuses on the research on the low temperature heating characteristics of the new energy vehicle gas supply enthalpy low temperature heat pump air conditioning system.

1. Introduction

At present, most of the air-conditioning systems installed in the car use refrigerant R134a high temperature refrigerant, which has a good cooling effect, but there are drawbacks, if the ambient temperature outside the car is not more than 10 degrees Celsius, the compressor exhaust temperature will rise rapidly, can reach 120 degrees Celsius, at this time, the system will appear serious attenuation, resulting in the air-conditioning system can not work properly, if the air-conditioning system to maintain normal use to ensure its effective heating, but also need to install auxiliary heating equipment. According to some researchers, there is a heat pump system using carbon dioxide as a refrigerant, the effect is better than the heat pump system using R134a refrigerant, especially in the low temperature environment, the thermal performance of carbon dioxide is good, it needs to be emphasized that carbon dioxide is a natural refrigerant, not only can be cooled, but also has environmental protection value. However, if carbon dioxide is used as refrigerant, the heat pump system will have high pressure in the process of operation, which will affect the safety and reliability of the system operation. compared with carbon dioxide refrigerant, the thermal conductivity of the R410A is good, and it also has the characteristics of flow. compared with R134a refrigerant, it has very low permeability, it is not easy to produce leakage problem, and the temperature range is relatively wide, and there is no high requirement for the dryness of the system. During the operation of the system, the pressure is high and there is a large air tightness. If the flow rate of the compressor is relatively small, the pipeline is relatively fine, it can also be used, and the cost of consumption is relatively low. Now the R134a refrigerant is used in the automobile under the low temperature condition, the gas temperature emitted by the compressor is relatively high, and the heating performance is seriously attenuated. The R410A air supply and roasting heat pump type automobile air conditioning unit has good heating performance.

2. Air-Conditioning System of New Energy Vehicle Gas Supply and Roasting Heat Pump

In order to reduce energy consumption and save energy, the structure of air-conditioner and the temperature range of battery should be considered. If the air conditioning system installed in the new energy vehicle uses a R410A gas supply and baking heat pump, the minimum operating

  DOI: 10.25236/cseem.2020.106

temperature of the battery system is minus 15 degrees Celsius. From the composition of this heat pump air conditioning system, it includes the car evaporator, car condenser, four-way valve, valve parts, rotor compressor, throttle valve, gas-liquid separator and so on[1].

3. Test Conditions and Methods

The performance of the whole air-conditioner is measured by experimental method, including two methods: the first method is balanced room calorimeter method, the second method is air baking difference method. The advantage of the former method is that it has high precision, but it also has defects, that is, it has high requirements for testing and needs to invest a lot of test fees. If the latter method is used in the test, the air baking difference method, when the test plan is formulated, it needs to be carried out in accordance with the national standard, such as the test method of the automobile air conditioning refrigeration unit and the performance requirements of the automobile air conditioning refrigeration unit, etc., to explain the related problems in detail, which needs to be strictly enforced. Enterprises can also use standards in the testing of air conditioning systems, such as the United States General Standard is passenger car A/C system maximum performance verification. In the course of the test of air-conditioner baking, the experimental unit is installed on the bench, the heat exchanger inside the vehicle and the supporting assembly of the air conditioning system are placed on the indoor side of the laboratory, and the main part of the bench, such as compressor, is placed on the outside of the laboratory. (Figure 1: Laboratory side; Figure 2: Laboratory outside)

Figure 1 Laboratory indoor side

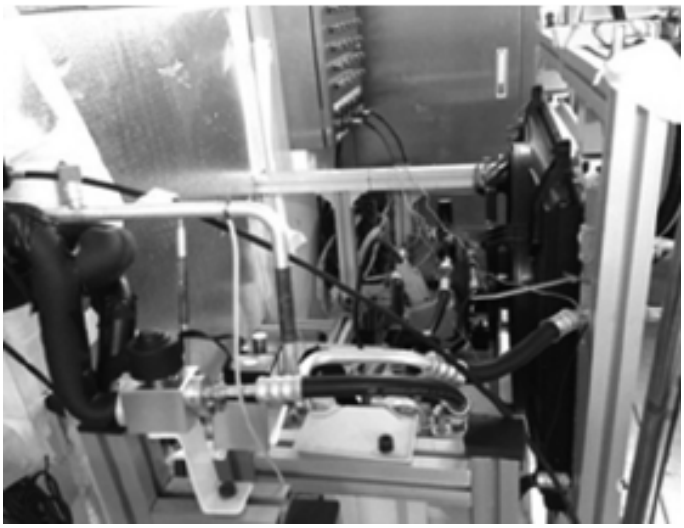

Figure 2 Outside laboratory

4. Experimental Results

The air conditioning system of new energy vehicle is compared R134a heat pump system and R410A air supply and roasting heat pump system. The range of exhaust temperature of compressor is different, the ambient temperature is constantly changing, and the exhaust temperature shows a certain rule. the variation of ambient temperature is shown in figure 3. (Figure 3: Chart of variation of ambient and exhaust temperatures)

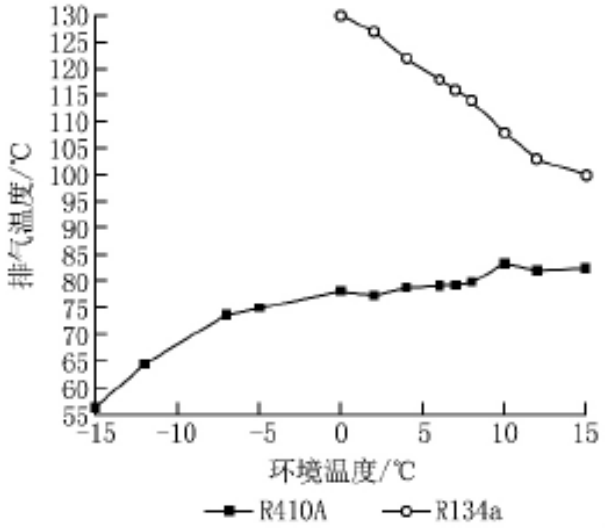

Figure 3 Patterns of changes in ambient and exhaust temperatures

By reading Figure 3, it's clear, In the case of ambient temperatures, Gas emissions from air-lift system compressors using R134a refrigerants can be heated at home, From 100 degrees to 130 degrees, The main reason for this phenomenon is that the ambient temperature outside the car is relatively low, The heat exchanger outside the car reduces the evaporation pressure, The suction pressure of the unit is reduced accordingly, As the compression ratio increases, The exhaust temperature has also increased, even exhaust temperature to 130 degrees Celsius. In this case, The exhaust temperature has exceeded the exhaust limit. This test method is used to obtain the limit of exhaust temperature of the test unit, When it's actually running, If the ambient temperature is 4 degrees Celsius, If the exhaust temperature is up to 120 degrees Celsius, the operation of the system will stop. During the security period, In low temperatures, To get enough heat, You need an electric heating device to compensate for the temperature, This could lead to additional energy consumption in new-energy car batteries, If the engine doesn't have the heat to use, New energy car air conditioning system will stop running. R410A refrigerant used in the new system, Combined with a gas supply structure, The air conditioning system can control the heating range within a reasonable temperature range, ensure its reliable operation. By analyzing figure 3, When the ambient temperature drops, R410A the exhaust temperature of the system will decrease, When the ambient temperature is 10 degrees Celsius, The maximum exhaust temperature is 83 degrees Celsius, If the ambient temperature drops to minus 15 degrees Celsius, The unit remains in normal operation, Its exhaust temperature is 55 degrees Celsius.

comparing the heating performance of the two systems, see figure 4. (Figure 4: Heating performance parameters of two systems in ambient temperature change)

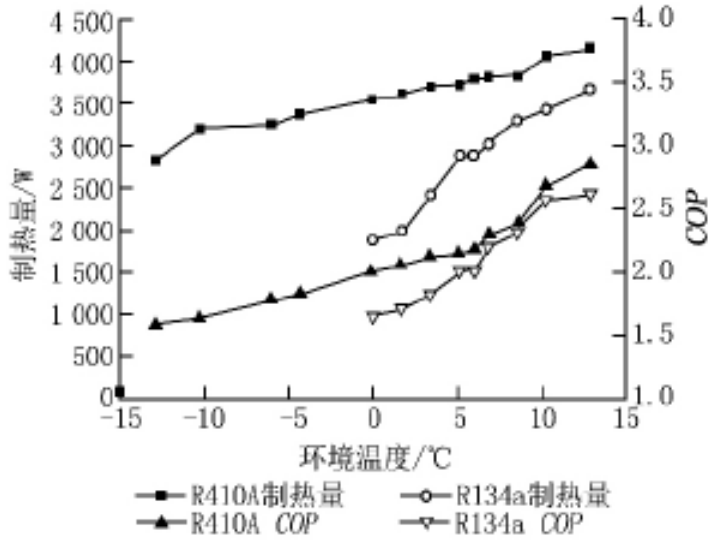

Figure 4 Heating performance parameters of two systems during ambient temperature change

The analysis of figure 4 makes it clear, The heating performance of the two systems is obviously different, When the ambient temperature drops, Both systems reduce heat production. When the ambient temperature drops from 15 degrees Celsius to 0 degrees Celsius, R134a the system is running, The heating capacity of the unit is greatly reduced, From 3.674 kW to 1.885 kW, COP reduced from the original 2.7 to 1.7. This is mainly due to the lower ambient temperature, The system also lowered the suction pressure, The specific volume of refrigerant increases significantly, It reduces the mass flow rate of the circulating working fluid, Visible, Air conditioning heating and COP are significantly reduced. R410A system is added to the gas during operation, When the ambient temperature drops to minus 15 degrees Celsius, The heating capacity of the unit has not changed much, Already at 2.822 kW, When the ambient temperature is 15 degrees Celsius, COP 1.6. When the ambient temperature is 15 degrees Celsius, The heating capacity of the unit reaches 4.156 kW, COP is 2.9.

R410A have excellent properties, which means that the heating interval is wider, when in the subzero environment, the R410A system is still in good operation, R134a can not have such an effect. When in the subzero ambient temperature, the exhaust temperature of the R134a system is too high, it is necessary to use an auxiliary electric heating device to compensate the heat through its heating. From this point, it can be clear that the energy saving effect of the R410A system is good, and the power consumption of the battery is greatly reduced. When the R410A is in operation, the pressure is higher than the R134a,, it will reduce its flow loss and heat transfer performance is better, because of the high gas density, in the case of the same heating demand, even if the pipeline is very thin, or very small with the valve, its mass flow working fluid is the same as the R134a, the manufacturing cost is greatly reduced.

5. Concluding Remarks

It's clear from the research, Refrigerants used R410A new energy vehicle air conditioning units, Combined with gas supply and baking heat pump technology, Its energy efficiency is better, Compared with the heat pump air conditioning unit using R134a refrigerant, more suitable for use in low temperature heating environment. As a result of the experiment, A wide range of heating operation is applied to R410A gas supply and roasting heat pump system. than R134a system effect heating effect is better. When the temperature is 15 degrees below zero, The exhaust temperature is 56.3 degrees Celsius, When the ambient temperature reaches 10 degrees Celsius, The maximum exhaust temperature can reach 83 degrees Celsius, During the operation of the unit, can ensure that the exhaust temperature range is reasonable. When the ambient temperature drops to minus five degrees Celsius, Without the auxiliary electric heating, It's 39 degrees Celsius, In-car heating requirements can be met. When it's low, If the auxiliary electric heating unit is used for heat

compensation, can reduce the energy consumption of batteries. R410A refrigerant, Pre-shrink the heating capacity, More than 17%, Overall energy efficiency will increase by 21 per cent. Application of R410A refrigerant can solve the problem of serious attenuation of heating performance in low temperature environment.

References

[1] Cai, Zhimin., Li, Jianguo., Li, Chunlai. Experimental performance analysis of air-source heat pump based on air-jet enthalpy. Science and Technology Innovation and Application, no. 10, pp. 51-52, 2019.